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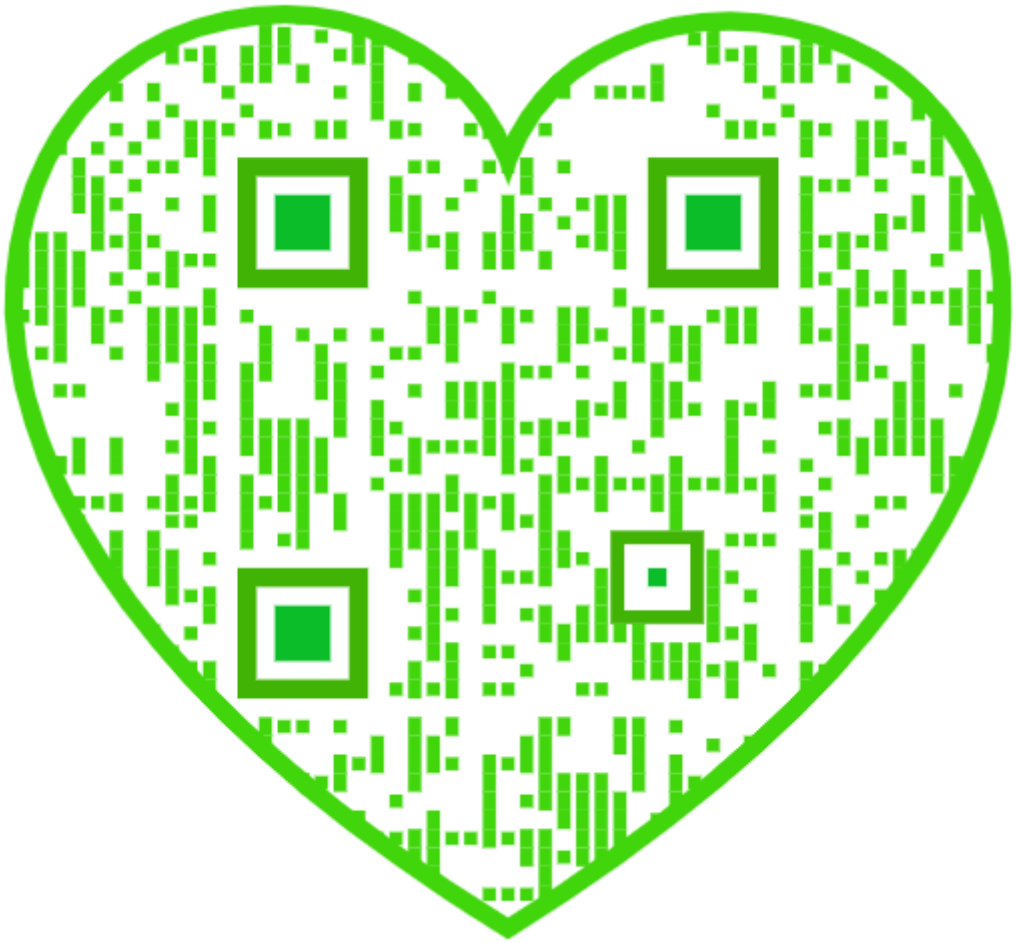
Scientific Potato Culture

By A. J. Young, Sr.

PRICE $2.00



Scientific Potato Culture

A BOOK, CONCISE IN ITS FORM, AND CONTAINING A MINT OF SUGGESTIONS REGARDING THE POTATO AND ITS CULTURE.

By A. J. Young, Sr.

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1918

MAR -5 1918

FROM THE PRESSES OF
HUNTINGTON BEACH NEWS
HUNTINGTON BEACH, CAL.

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The old home where I have carried on my experiments for twenty-three years.

A. J. Young, Sr., the potato expert, who has gained his knowledge through experimenting and growing the crop for twenty-three years.

AUTHOR'S PREFACE.

HIS book is written with the hope of fulfilling the various needs of the potato growers of California. Many suggestions will also prove beneficial to the eastern grower. Since the potato is the foremost food plant of the American people, the author has endeavored to give in as brief and complete form as possible the much-needed and valuable information. Since the author has made a life study of this problematical plant, there are some profitable suggestions unfolded to the reader within these few pages. Such knowledge is the author's personal experience, having learned from this, the world's greatest teacher.

The book contains some interesting experiments on the plant as well as the practical culture of the potato.

A thorough study and strict observance of the instructions herein will insure the most amateurish growers of California remarkable success.

July, 1917. A. J. YOUNG, SR.

CONTENTS

Page

Chapter 1. Breeding.....15
Pollination and crossing plants, and propagation of new varieties.

Chapter 2. Selection and Care of the Seed Potato.....25
The cause of "run out" potatoes. Qualities good seed should have. "Hill selection." "Greening."

Chapter 3. Cutting and Preparing the Seed to Plant.....45
How to cut, and size, of seed piece. Liming the cut seed. The use of whole seed in California.

Chapter 4. Preparing to Plant and Planting.....55
Fertilizers. Essential plant foods in soil. Soils best adapted to culture of potatoes. Preparation of soil. Planting seasons.

Chapter 5. Cultivation and Irrigation.....67
First cultivation. How to irrigate. Hill culture or ridge system. Level cultivation.

Chapter 6. Disease and Its Prevention.....75
Spraying. Preparation of Bordeaux mixture and Paris Green. Insect pests. Causes and prevention of diseases.

Chapter 7. Harvesting and Marketing.....85
How to grade for market. Sources of influence upon quality of the potato.

TABLE OF ILLUSTRATIONS

	Page
The old home	3
A. J. Young, Sr.	5
Potato bloom ready for pollination	13
Potato fruit and seed	17
A perfect two-year seedling	21
The best hill of seedlings I ever produced	27
A potato in good condition to plant	33
Results of planting a potato when too old	37
My 1916 field of potatoes	41
A cutting ready for planting	53
How to plant to reproduce on top of the vine	65
Potato insect pests	71
A potato affected with wilt	78
The Scottish Chief potato is the best marketable tuber known	83
Young's Early Harvest King	87

The upper bloom shows the exact time for pollination.

BREEDING.

CHAPTER I.

F all interesting studies of plant life, the problems confronting the potato breeder, also the nature of the plant, are the most interesting to me. There are numerous difficulties in potato breeding. He who would succeed must discover for himself these obstacles and overcome them.

I have studied the nature of the potato, have experimented, have propagated many kinds, and have grown the potato extensively for about twenty-three years, and every day there are different problems confronting me, most of which I have solved, yet there is deep study ahead and much to be learned. I have grown potatoes from cuttings, and from such cuttings have grown four crops in one year, each cutting being taken from the vine that had been grown from a cutting. The first cutting was taken from a seedling, which would make four crops without using a tuber for seed. I have learned how to grow potatoes on top of the vine, and many more interesting experiments, and find there are always new ideas presenting themselves.

Some of the problems confronting the potato breeder are: In some cases it is impossible to cross one desirable potato with another which has otherwise good characteris-

tics, because of non-production of fertile pollen. Again, he must grow a great number of varieties in order to determine which have viable pollen. The climatic and soil conditions greatly influence the production of fertile pollen. There are some varieties of potatoes whose buds drop off before opening, and some that have a few flowers open but fall too soon. There are also some whose flowers live for several days but frequently the pollen is not fertile. Again, many times when the blooms do appear and the pollen is fertile, in some cases the seed balls or fruits are seedless, and if they do have seed it does not always germinate. Instantly a question arises in our minds, "Is there a means by which we could produce this coveted fertile pollen?" There are, however, a few varieties which generally produce viable pollen. The disease resistance of a tuber plays an important part in this matter.

After these difficulties have been overcome, the actual crossing of the plants is an easy matter. The plants to be selected for crossing should be strong and healthy, with good characteristics. The mother plant should be especially strong, having a desirable feature that is lacking in the male plant, and the male plant possessing some characteristics which would make a good cross.

There are two ways of pollination. First, nature's way, self-pollination. Second, hand pollination, of which there are several methods.

One method of hand pollination is as follows: First, the female plant is deprived of its anthers. The anthers stand erect in the center of the flower, like a cone. These flowers are then covered with paper bags with some foliage to insure moisture, for proper development. After this, in about two days, the male plants are gathered, the pistil removed and the pollen jarred onto the emasculated plant.

Potato fruit and seed.

The pistil is the small, cylindrical form in the center of the anthers. Within a week's time the blooms will have either swollen or dropped, thus determining the success or failure of this method of pollination.

Another method of hand pollination is: After the selection of the mother plant, the corolla, or inner petals, and the stamens are cut away before fully developed and then the blossoms are bagged. At the proper time for pollination, the pollen is collected from the male plant with a fine camel's hair brush and is then dusted on the mother plant. This is repeated for two successive days; that is, if the pistil has not fallen. When the fruit has begun to form, the paper bags are removed to allow free access to the air and light. When the seed balls are ripe, they are gathered and allowed to dry. They are then squeezed out, as they are liable to decay if left in the fruit.

Still there is another method, one which the Japanese are said to use, and is very simple. The flower of the male plant, when in proper condition to pollinate, is dusted by hand onto the mother plant. The plant is then covered to keep stray pollen off the pollinated flowers.

Another method, one which I have found best in my experience, one which is nearest nature's way, therefore we would conclude it to be best. I do not cut the flowers in any way, but when the flowers are to be pollinated, I limit the blooms to two bunches, and, with the use of a fine camel's hair brush, lightly dust on the pollen of the male to the mother plant. These always being desirable crosses. Before this, however, when the mother plant is beginning to bloom, I cover it with a cheese cloth. A frame can be easily made by pushing laths or sticks into the ground around the vine to keep the cheese cloth from touching it. Thus by the use of the cheese cloth the blooms have free access

to the air and light, and in no way can stray pollen fall upon the blooms. The proper time for pollination is about the second or third day of bloom. The pollination is repeated for two successive days; that is, if the pistil has not fallen. The cheese cloth should be left on for about five or six days. When the fruits are thoroughly ripe they are gathered, seeds squeezed out, washed in a cheese-cloth bag, and allowed to dry.

It is always a wise plan to select strong parent plants, because they develop larger and better seed. These seed in turn develop larger potatoes the first year from the seed than those from a delicate plant. It is of greater importance that the mother plant be strong than the male plant, and care should be taken in selecting the most vigorous ones.

This is a fact not known by most potato experts, if any. The way of determining the actual fertility of the potato fruits or seed balls without the aid of a magnifying glass: The balls are partially or wholly covered with small, white pimples. The smooth fruits are rarely, if ever, good.

I have, in selecting crosses, chosen those with about the same qualities, with the idea of improving them; while at other times I have crossed the opposites, with the idea of obtaining different and better qualities. These ideas are both good, providing the crosses used possess favorable points. I have noticed that the potatoes not seemingly closely related have greater affinity for one another than those which are apparently related.

I would not advise the potato breeder to use too much fertilizer on the first-year seedlings. This policy is followed by some, but is not a wise plan. The potato vines generally grow rank and scarcely any tubers are to be found. Some breeders use food material to induce variation, but the potato naturally tends to vary even if crosses within a variety

A perfect two-year seedling

are used. However, after the first or second year from the seed, large vines do not indicate that such excessive top growth is opposed to the formation of tubers, as some believe. I find that large vines make large tubers and a greater quantity. But if a so-called "run out" or "stray" is found, it must be noted that the vine is overgrown and very few tubers are to be found.

In selecting the seedlings from year to year, always choose the one nearest your own ideal of a perfect potato. Keeping this in mind, select and plant for eight years; or, if planted twice a year, for four years. By this time your potato will have reached a true-to-type one.

The seedlings must be grown several years in a comparison test; that is to determine the best type before a definite selection is made. The discovery of a way in which potatoes are bred up to a pure strain within less time is of great advantage to the potato world.

By the use of the potato cuttings from seedling vines making four crops in one season, then the tubers produced used for early spring and fall planting for the next two years, the development would be shortened.

In comparing and selecting the seedlings each year the qualities to be kept in mind, in addition to productiveness and uniformity in size and shape, are:

1st. The largest seedling should be selected each year. By so doing the potato will have reached its highest state of development within a shorter period or will be a larger potato when developed, which is a quality the people of California want.

2nd. Select those that are hardiest, consequently less liable to disease. The vigorous potatoes are more drought or disease resistant, and by the selection of such progeny the breeder is always assured a potato of good quality and yield.

3rd. Those that are most adapted to peculiarities in climatic and soil conditions.

In cutting seedlings, it is always advisable to cut and throw away the blossom end of the potato; that is, the bud-eye cluster. This end, when planted, is more liable to cause prongy tubers, although the tubers produced from this end are more disease resistant.

In order to insure a good development during the first year or season's planting of the potato seed, it is advisable to allow the seedling a long growing period. They require from five to nine months, depending on all conditions. It is well to plant as early as possible, if planted in the field.

SELECTION AND CARE OF THE SEED POTATO.

CHAPTER II.

IN the growing of a profitable crop of potatoes, I would say that the first important factor is that of good seed. The next of importance is good soil. Without both these necessities, a good crop of potatoes cannot be produced. Good seed potatoes are known by their yield and quality when cared for properly. Good seed will produce a fairly good crop in poor soil, but poor quality seed in the most fertile soil will not give good results.

The average potato grower is careless in that he allows his seed stock to become mixed with other varieties. This is decidedly undesirable. These mixtures are generally of a poor quality, and the grower should look to discarding them, as well as the diseased ones. This demands, or should demand, the special study and attention of the grower. Study and learn the varieties, and discard the unproductive strains! Again I would emphasize the importance of unmixed seed. If a mixture of early and late potatoes were planted, the result is, naturally, an uneven germination; and scarcely any of the late tubers are set on when those of the early varieties are ready for market. The great loss to

the grower can be readily seen, and is enough within itself to pay for the good seed.

The majority of potato growers in California and elsewhere use "culls," or inferior seed. Thus doing, they invite an unfavorable quality as well as yield. The belief that is prevalent throughout the country that the average cultivated potato shows a tendency to degenerate or "run out" is true. It is quite a natural result, caused from lack of knowledge or carelessness in the selection of the seed potatoes. The inferiors are used year after year, and the resultant crops are very poor. The fact that like produces like is essentially true in the potato as well as other plant life. If the best of seed were used, planted in good soil and handled properly, this tendency of degeneration would soon be overcome, and better prices could be demanded for the better grade of potatoes. If studied closely and carefully, each variety may be found to have unproductive strains. These potatoes are generally curly topped. These should always be discarded, so that the variety grown be kept to its highest standard of development.

In my experience I have learned that strong plants produce many times the number of good tubers than the weak plants, and in some cases the poor seed does not produce any marketable tubers whatsoever. Therefore, I would say that the selection of seed should be conducted with the greatest of care.

Now arises the question, "What is good seed?" Too much stress cannot be laid on this ever-important and interesting subject, the production of good potatoes.

1st. The tubers used for seed must be strong, vigorous, and productive.

2nd. Must be pure and unmixed.

The best hill of seedlings I ever produced, being eighteen smooth potatoes, and not an ounce difference in weight.

3rd. Should be firm and with the sprouts just showing at planting time, as shown on page 33.

4th. Should have been selected at digging time. This is called "Hill Selection."

5th. Must have been carefully and properly handled.

6th. The seed should not be too ripe or mature.

7th. The seed should not show any disease whatever, or have any rotten spots.

8th. The seed must not be too old or too new.

Potatoes that have been sprouted two or three times are not the best for seed. They are too old. Each time they are sprouted they become weaker. When they are at this age, the sprouts, if there are any, are weak and thread-like. If such potatoes are planted, they will not grow, as they are too delicate to send out a top. If they do happen to grow, there will be small, pea-like tubers form just in or outside of the eyes. The seed piece may be firm, but because of the age it will not reproduce. The nature of the potato is to reproduce, so if it cannot send up a top, the small tubers will form in the eyes of the old potato. If these old tubers are opened, it will be noted that they are hollow or are water-soaked, and the quality very poor. Page 37 shows such a potato that had been planted for three weeks.

The newer seed, that with the first sprouts just showing, comes up more readily and possesses greater vitality than older seed. That is one of the serious faults of the growers in some districts of California. They use seed that is old and has sprouted badly. The sprouts are sometimes several inches long before the potatoes are planted, consequently the potatoes have not the strength left in them to make a good crop. Those plants that do come up are weak, therefore more subject to disease. In some experiments I

have tested new potatoes with the sprouts just showing, and old ones that had been sprouted in soil infected with jelly-end and rot. The tubers from the new seed did not show a sign of the disease, while those of the old seed were badly infected. The new seed is more liable to be prongy or knotty, but this can be overcome by cutting away the blossom end.

Another serious fault of some potato growers is to leave culls lying on the ground from year to year. The weaker hills are always more liable to disease and always produce small tubers. If these small tubers or culls are left on the ground, the new crops and the land is bound to become infected with the disease; and if this way of handling the crop is continued, the disease will increase with great rapidity and soon no crop can be raised.

I have noticed in a volunteer hill of potatoes, where they have lain on the ground over winter, that the center eye in the bud or blossom end is always the first one to sprout. It is this eye that produces the crop resulting in prongy tubers, and I maintain that this center eye in the blossom end is the eye that finally causes the "running out" of the potato, although it is the strongest eye and is the first to come up when planted. The grower should not, therefore, under any circumstance, allow culls to lay on the soil where the same crop is to be grown the following year. These culls cause the degeneration of the potato, breed diseases and tuber moth. If, instead, these culls were used for stock feed, either in the raw state or cooked, they would more than pay for the trouble, and the following crop would be greatly improved.

I have learned that it is wise to change the soils used for potatoes from year to year. If they are planted in peatland one year, the seed produced should be planted in a

lighter, but not too light, loam the following year. The stand and yield is always increased. This is a practice not known to most potato growers.

The year 1916 I had a 98% stand, and a yield at the rate of four hundred sacks per acre. This land has been in potatoes every year for twenty-three years. I attribute this to the **selection of good seed,** planted at the proper time and well cared for. The field picture is shown on page 41. We would naturally conclude, then, that the value of good seed cannot be overestimated. As much cultivation is put into a 50% stand as a 98% stand, and almost the same expenditures would produce a 98% to 99% crop. The gain in the resulting crop from the use of good seed would be surprising. While the 50% stand would hardly pay expenses, with an 80 to 85% stand the grower would realize a good net profit. When potatoes are a good price, a great number of farmers buy any seed just so it is cheap, plant it, and expect a good crop. Instead, the results are poor and a very inferior quality of potatoes are produced—thus the loss of time and money. They find that they cannot obtain a good price for such quality of potatoes, so sell them at a very low price to get rid of them. This floods the market with poor quality potatoes, consequently the conscientious grower will lose indirectly to a certain degree. Then the inexperienced farmer decides there is nothing in it, so stops growing them until the price is high again, when he begins again enthusiastically with the same method of poor seed, and naturally produces the same results.

The man who makes a success in potato-growing, as in any other business or profession, is the one who has the stick-to-it-iveness. He is the one who will get the best of seed, no matter what the first cost is, and will always produce good potatoes. He will get the best price for them,

because such potatoes are very scarce. In fact, it is a hard matter to find them. That is the reason I advocate so strongly the use of good seed.

You may ask, "How will we tell good seed?" By looking at them it may be ascertained whether or not they are sound, firm, or diseased to a certain extent. But whether or not the seed will produce a good crop cannot be determined. The only way, then, is to try several varieties in your particular soil. By hill selection year after year of the best (that is, the most productive and of the best quality), your potatoes may be brought up to a high standard of development. But if the growers cannot take this time to learn the best, it is always advisable to buy of some recognized seed potato grower, or a reliable seed firm.

I have some potatoes that cannot be surpassed for peat land or damp, heavy soil, although when planted in the peat land they would not sell for marketable potatoes, as they are too large, rough, and deep-eyed. This same potato, when planted on other loamy soil, makes the largest yield of any I have ever tested. They are of a good size and exceedingly good for market. It is quite a remarkable fact, the difference in size and shape in a variety of potatoes grown in different soils. Those grown on weaker, light soils are likely to be more smooth and uniform, as far as looks are concerned. When seed quality and vitality are considered, the tubers that are grown on the rich soils are far superior, though they be rough, deep-eyed, and ill-shaped. This potato, if changed to a lighter loam, will come out smooth and large; also the yield will be greatly increased. Inheritance plays an important part in the size and shape of the tuber, yet to a great extent these factors are determined by the kind of soil, fertilizer, and care given the crop.

There is an increasing demand for fancy table stock,

A good seed potato, in proper condition to plant.

and if the use of good seed were persisted in, the grower would be paid the higher price for the better quality potatoes, and consequently the subject of "Improvement of the seed potato" hence "The development of high grade marketable tubers" is receiving more attention than heretofore.

The successful grower gives his most careful attention to the source of his seed supply. He either becomes an expert himself in the growing of the crop or buys of some recognized seed potato grower or seed firm. As a result his average yields are enormous in comparison to the one who is careless in his seed selection.

The development of the best grade seed potatoes is not a perplexing problem; however, great care, attention, good judgment, and correct methods must be persisted in year after year. If the grower has not the time to develop his own seed into the best grade—seed of the best quality and highest productiveness—he must, for several reasons, buy his seed from a recognized seed potato grower—one who makes a specialty of growing varieties of a pure, strong, and vigorous type. It is preferable to buy of one whose seed potatoes are grown on rich soil, as this seed is more vigorous and will be more disease-resistant. Thus he will obtain better results from the seed grown in this soil than that grown in lighter soils. Never obtain seed from a seedsman whose stock is not free from mixtures with other varieties. To insure the maintenance of their strength and vitality the seed must be kept pure. The grower's average yield of marketable potatoes should be from two to four hundred sacks per acre. This insures the buyer the best of seed.

Considerable dependence can be placed upon the appearance of the tops in hill selection. The vine with one hardy stem is always better than two or three weaker ones. When

once learned, the tops will tell about the yield to expect, the size of the tubers, the number, and where they lay can be easily determined. When the grower is able to do this, he may figure very closely the yield per acre, what proportion will be of marketable size, and the proportion of culls. The tops of the potatoes will vary in different soils and varieties. Some will be different in color and the leaves shaped differently. Where the soil is extraordinarily rich, it will be noticed that the hills with two or three stalks have better marketable potatoes than those with one stalk. Where the soil is so rich, in a hill with just one stalk, the tubers will be too large for market. If the soil is weak and light, it will be noted that the large top with one sturdy stem produces a better size than those with more.

To those who care to grow their own seed to improve them, thus raising their potatoes to a high standard of development, I advise to carefully select them at digging time. This is called "hill selection." These potatoes should be carefully dug by hand, avoiding cuts and bruises. Each man should use two cans, one for select tubers of uniform size and shape for seed, the other for marketable tubers. Each hill should be dug separately. If in a hill of potatoes one be rough, or in any way defective, this hill should not be used for seed.

The development of the potato to its highest standard has proven as interesting to me as the fascinating study of the propagation of new varieties. In my hill selection I have taken particular care in selecting only hills with an average of eleven or more uniform tubers. This eliminates all unproductive plants. In continuing this line of work an excellent strain of potatoes is always secured. The best potato growers always place emphasis upon keeping the potato true to type. If we want the best we must of necessity

The results of planting a potato when too old
tato was dug after being in the ground for +'

plant the best. The best strains always produce the best in plant life as well as in animal life.

To the growers of California, I cannot too strongly emphasize the necessity of pure, vigorous seed. They are largely exempt from disease; and if the soil is infected with disease, fertilize and plant to different crops that do not breed these diseases until the soil is rid of it. When potatoes are grown again, be careful to select only the best of seed, and, with the care of the crop I advocate, the yields will be wonderfully increased.

In handling the crop the tubers should not be moved too often; however, they should not be left in piles on the field to sprout and lose their strength.

Potatoes for seed should always be "greened" when using early spring seed for fall planting. Greening is to cause them to sprout under certain conditions before planting. In other words, they are put into proper shape to grow.

The seed produced from the April planting for planting in April of the following year becomes a little old before the time to plant, and it is a difficult problem to stay their growth and preserve their strength. They are stored in a cool place until the cold weather in the fall appears. Then they are put into a dry place before the rainy season comes, and when the first sprouts begin to show they are put out to green and are left in that condition until planting time. The sprouts are generally from one-half to one inch long at this time, and are always planted with these sprouts on. The sprouts become tough, and are hard to remove. This seed, when properly handled, always insures a crop about two weeks earlier.

The importance of greening is twofold:

1st. If allowed to grow or sprout too readily before planting, too much strength is taken from the potato, caus-

ing it to shrink. Therefore, the plants are stronger, are healthier, and more vigorous if greened, and an increase of yield is the result. The average increase in yield of greened over ungreened seed is, in most instances, about twenty-five per cent.

2nd. The tubers, when planted, mature in a much shorter period when greened, and can reach the market much earlier. Since it takes a shorter period to mature, the potatoes do not have as much chance to take in disease as when left in the soil longer. Again, if the seed is kept in trays and greened, they will keep longer for seed purposes than if kept in bins, sacks, or piles.

In greening, the potatoes should be placed not more than two or three inches deep, and arranged so that plenty of air and light can reach all tubers. They should be kept in a cool, dry, shady place. An open barn or shed is generally used. Seed potatoes should always be kept in moderate temperature. Some farmers' ideas of greening their seed are very poor. Their idea of greening is by the sun, never once thinking that the extreme heat is as injurious as frost. The tender potatoes just taken from the soil will stand but little heat in the sun. It is essential that they be kept in the shade.

In conclusion of this chapter, "Selection and Care of the Seed Potato," I would again emphasize the necessity of good seed, for good seed is far cheaper than poor seed.

1st. Remember that marketable potatoes can be produced on poor soil with good seed much more easily than poor seed grown on good soil.

2nd. Good seed may be obtained by a thorough and careful "hill selection."

3rd. All tubers showing any disease or rot should be rejected.

The 98% stand I produced in 1916. This soil has grown potatoes for twenty-three years, and still yields abundantly.

4th. Select pure and unmixed seed.

5th. Weak seed produces weak plants.

6th. Greening is essential in most cases.

7th. In unselected seed stock the greater per cent are weak and diseased, therefore unproductive.

8th. Beware of the dealer who thinks more of the price than of the quality of his seed, or one who through carelessness and inexperience does not keep his seed unmixed and vigorous.

CUTTING AND PREPARING THE SEED TO PLANT

CHAPTER III.

AFTER the seed potatoes have been greened (when greening is needed), they are cut, limed and allowed plenty time to heal over before planting. The potato should be cut, first, lengthwise through the bud-eye cluster or blossom end, and then crosswise, depending upon the size of potatoes used. Each seed piece should weigh not less than two ounces. However, the piece at the stem-end should be larger, as this end of the potato is weaker and therefore more subject to disease than the bud-eye end. It is essential that they be of good size, as each seed piece must have strength enough to support a sprout, or sprouts (as the case may be), until the feed roots are able to support them. The sprouts take all the strength from the seed piece until the feed roots are long enough, when the little "pumps" on the end of the roots start working and drawing up the plant food by capillary attraction from the soil. Therefore we would reasonably conclude the advantage of using a large seed piece. If it is not large enough the sprout will be stunted and the crop likewise will be lessened. There should be one or more, and not over three, good eyes in each piece, and the eye or

eyes should be as near the center as possible. Do not cut too close to the eye.

Some potato growers, particularly in the Eastern states, cut out only the eyes and use them in planting. This has been tried and will not do in California. As I have explained, the seed piece must of necessity have the strength to force the sprout, thus increasing the yield. Those who practice using the eye alone for planting would get much better results if, instead, they would use a large seed piece.

Some times when seed potatoes are high and scarce, the grower will cut the seed into very small pieces, making his seed go farther. It does, it is true, plant a larger area, but when the yield is taken into account, he will surely see his mistake. This is a common error, and is, indeed, a serious one. The grower tries to be economical by cutting his seed into small pieces. The lack of results from the use of small pieces would more than justify the use of large pieces. The fact that the smaller pieces will plant more ground will also make the grower more work and will not produce any more tubers than the smaller plot of ground and larger pieces. Again, the piece is liable to decay before the feed roots appear.

The discussion of the size of seed pieces brings up the subject of the quantity of seed to use per acre. This depends upon the manner in which the seed is planted, the distance of the hills and the rows, and the size of the seed piece; also if whole or cut. I generally use from six to seven hundred pounds per acre in ordinary soil, but in rich soil not less than one thousand to fourteen hundred pounds per acre. This, however, cannot be definitely stated. More seed is used in rich soil because the seed piece must be larger and each piece have more sprouts. If there is just one sprout the new tubers will be too large. One sprout will

make one sturdy stem. Such hills are usually found to have less but better tubers under it than a hill with several weak ones, when planted in ordinary soil. The grower should be thoroughly acquainted with his soil, he should know the quality of seed, and the condition his soil is in before planting. Then he may know about the quantity to use.

If there are, by chance, any potatoes in your seed stock showing decay, cut and throw that part away. The decay or disease generally shows in the stem end first. If there are any yellow or black streaks, cut that part away, too, as it is disease. If the yellow streaks reach through the potato, it will not do for seed; but if only part of it is infected, that part which is good may be used for seed. Again, you may find in your seed stock some potatoes that have been sprouted once or twice. These are too old to plant, and should be cast aside as inferior. Any disease that is left in the seed piece will inoculate the new crop of potatoes. As the strength goes out of the old potatoes into the sprouts and thence into the new tubers, so will the disease.

The grower should cut and lime the potatoes to be used for seed several days before planting. If the seed is new and not sprouting, it should be cut and limed from eight to ten days before planting. If the seed is a little old, it should be cut about five days before planting, to keep it from losing its strength. Seed when cut and limed always proves to produce much more than when unlimed. The use of lime on seed potatoes serves well several purposes:

1st. It prevents, to a certain extent, bugs and worms eating the potato.

2nd. Lime within itself is a fertilizer.

3rd. The seed that is limed is less liable to disease, as it prevents disease germs entering the tubers. Disease germs never enter the potato unless the skin is broken or

cut without being healed over with lime. Therefore, if well covered with lime, the potato will be protected from disease germs to a certain degree.

4th. Lime acts as a preservative. The seed pieces will keep longer when planted with lime than without it.

5th. When cut potatoes are limed, a thick covering or new skin is made on the cut surface, and is stronger than the old skin. This keeps the seed from losing its strength.

6th. The expense is very small and no time is wasted.

Many growers believe that lime is a detriment to the growing of potatoes, but I am decidedly in favor of its use.

I have tested growing potatoes with and without liming when there are hard, black streaks reaching through the potato, this being the first stage of decay. I have taken ten potatoes, cut each into four equal parts, and planted without lime, and ten with lime. Out of the ten tested without lime, three came up before the pieces decayed, and the other seven decayed away before the sprouts came through. Out of the ten tested with lime, eight came up and looked a great deal hardier than the three without lime. This, I think, should prove the value of lime in the growing of a profitable crop of potatoes.

It is always advisable to procure the lime to be used several days or weeks before cutting and planting time, and air slake it. Since the starch in the potatoes absorb the lime, the cut tubers will be burned if the lime is too new; that is, if not well air slaked.

In slaking the lime, I always spread it out in thin layers so it will be exposed to the air. Several weeks' time is needed to slake it well before using. However, the time depends greatly upon the weather conditions. The test in determining whether or not it is well air slaked is to pour a little

water upon a small quantity of the lime. If there is any heat whatever, the lime is not well slaked.

Most potato growers, in the handling of their crops, use kerosene oil cans. The tops are taken out, the edges hammered down so the potatoes will not be cut or bruised, and a handle is easily fitted in at the top. These make a very handy can in the handling of potatoes. I use them altogether.

In cutting the seed potatoes, have ready a pan of air slaked lime, and a paddle that will hold about two or three tablespoons of lime. Cut about one-half of a can of potatoes and then sprinkle a paddle of lime over them, shaking the can at the same time. This distributes the lime well over the seed. That which does not stick to the potatoes will drop to the bottom of the can. When the can is full, sprinkle another paddle of lime and shake as before. When the cans of cut seed are emptied into the sacks, the lime that has fallen to the bottom of the cans will reach all sides of the seed.

After the seed has been cut and limed, they are put into sacks partially full. The sacks should not be piled or the cut seed bruised in any way. Let them stand with an air space between the sacks of about three or four inches, so that fresh air might circulate around and through them. Always keep them in a cool, shady place.

When seed potatoes have been harvested in September and October, and are to be planted in December or January or February, the seed must be cut two weeks before planting. If, however, this same seed is not planted until March, they should not be cut over two or three days before planting. Such seed would be considered old. They do not have the vitality at that time and would lose considerable strength if kept longer. When the seed that has been harvested in

November or December is planted in March or April, it should be cut about two weeks before planting. For good seed for the July planting, the seed to be used should have been harvested by the first of May, placed upon shallow trays and greened. Potatoes at all times should be kept in a cool, shady place. In my experience with the July and August planting I have learned that potatoes cut and limed from three to four weeks before planting come up more evenly.

Every grower should know his own soil. When planting in soil that is extraordinarily rich, the seed pieces should have more sprouts than when planted in lighter soil. But in soil that is not overly rich, the seed pieces should have but one sprout. In other words, the plant food which is lacking in the soil is made up in the strength of the seed piece, or visa versa. One sprout from a seed piece will produce as much in weight as three or four sprouts in the same soil and under the same conditions. However, the hills with more sprouts produce more in number, but the tubers are smaller than those produced from one sprout. For instance, if one potato when planted in rather light soil produces three sprouts, the tubers produced would be small, but if planted in rich soil the tubers would be a good size. But if in the same soil a potato is planted which has but one sprout, the tubers produced would be large, and if planted in rich soil the tubers produced would be too large. The fact that each hill has a certain number of square inches to draw its plant food from, makes it clear that the more tubers in each hill the less weight in each tuber there will be. The one tuber produced will weigh as much as the three smaller ones if planted in the same soil. In using new seed to plant, when the first sprouts are just showing, with a good-sized seed piece and planted in ordinary soil, just one

sprout will be produced. In such new seed generally just one sprout appears; but if aged, and under certain climatical conditions, all eyes will sprout, and two or three stalks may grow from each eye.

There are several reasons why whole seed is not used extensively in California: 1st. Because the small whole tubers used are generally "culls;" consequently an inferior crop is produced. Large pieces cut from large potatoes yield more. 2nd. The cost is greater, and more seed potatoes are required, and does not increase the yield sufficiently to justify its use, unless the soil is extraordinarily rich. However, if whole tubers are grown especially for seed purposes, planted closely so they do not become too large, they are satisfactory, and are much better than the small tubers taken from the field.

In European countries, whole seed, greened and sprouted, is used extensively, and such seed makes a crop from two to three weeks earlier.

Cut seed potatoes are generally advisable in California, although whole seed is advisable at times. Its use is growing more popular than heretofore.

The soil must be extraordinarily rich, or the seed new, so that just one or two sprouts are produced. Whole seed must never be too old. If the seed is too old, too many sprouts will come from one hill, making the tubers unmarketable. Whole tubers must always be very new to produce one sprout in light soil.

The use of small whole tubers from the field is not advisable, because it is generally the diseased plants that produce small tubers, and a very unsatisfactory yield and quality would result. However, when whole tubers are used, they should be from seed that had been planted closely es-

pecially for seed purposes, and the tubers dug while immature.

In conclusion of this chapter on "Cutting and Preparing Seed to Plant," I would impress on the grower's mind these facts:

1st. Always use good-sized seed pieces in planting. The stand and yield of the resultant crop from the use of such pieces will be very favorable.

2nd. Always lime with well air slaked lime, when cutting. Through the use of lime the crop will be less liable to disease. Lime is a fertilizer, acts as a preservative, and will partially protect the seed from being eaten by insects.

3rd. Always keep the seed in a cool, dry place.

4th. It is well to cut the seed pieces at the stem end of the potato larger than the other pieces. The strongest eyes are on the blossom end and each eye nearer the stem is weaker.

A cutting ready for planting. The use of cuttings is not profitable, unless the grower has only a few hills and wishes to increase the amount of tubers for the following crop, as four crops can be grown in one year. The line shows the depth to plant.

PREPARING TO PLANT AND PLANTING.

CHAPTER IV.

IT is of the utmost importance in the growing of a profitable crop of potatoes to cultivate deeply as well as thoroughly. The soil should be well fertilized with both the dry manure and a green crop, if lacking in humus. This green crop or mulch should be sown, preferably, in the fall of the year preceding the planting. By so doing the green crop will have reached the desired height by the time of the early spring planting. As soon as this crop is ready, plow under and prepare the soil thoroughly by the use of a harrow, if the soil has a tendency to bake or crust. This working will make the soil fine, mellow, and moist, an ideal condition for a crop of potatoes. In any soil it is well to plow the ground quite deeply, but do not turn up too much subsoil at one time. It is well not to plow more than two inches deeper than was plowed the year preceding, thus deepening the soil gradually until the desired depth has been attained. From seven to nine inches is a good depth to plow for potatoes.

The fertilizers used for the production of potatoes are dry barnyard manure, green manures, and commercial fertilizers. I have tested out several commercial fertilizers but without good results. However, the best fertilizers, those containing about 3 or 4% of nitrogen, 6 to 8% of phosphoric acid, and 8 or 10% of potash, give good results—one thousand pounds or more being used if spread broadcast, but if drilled along the rows, less than that amount is used. It should be mixed with the soil to prevent it coming in contact with the seed. The best fertilizers for the production of good potatoes is barnyard manure, followed by a green crop. This should be spread broadcast over the field. It should be put out in the fall and plowed under just before the sowing of a green crop. The best green manure or mulch is Texas red oats and vetch combined. This makes a heavy crop to turn under before or while plowing for the spring crop. It is a wise policy to combine the green with the dry manure, as the dry fertilizer used alone breeds scab—particularly if in close contact with the tubers.

This is a fact not known to most potato growers. The green crop during its decomposition forms an acid, counteracting the effects of the dry manure.

Nitrogen, phosphoric acid, and potash are the three essential plant foods in all soils, and are the most liable to be deficient after several croppings. These are the three plant foods needed in fertilizers. The dry manure contains a good per cent of these, and with the combination of this fertilizer and the green crop, practically all the plant foods are obtained. Clover is a good cover crop, as it takes the nitrogen from the air and thence to the soil. It contains more nitrogen than other legumes.

The "pumps" on the feed roots cannot absorb any plant food unless it is in liquid form. This is the reason that the

soil should be loose and fine. The plant foods are decomposed by the action of the light, sun, and air, and are, therefore, made soluble. Such fertilizers add the required humus to the soil. All legume crops, such as burr clover, vetch, Texas red oats, and Melilotus Indica—in fact, any legume crops—are good, providing they make a heavy crop.

The soil best adapted to the cultivation of potatoes is an extraordinarily rich soil. These soils are generally dark, being a mass of decayed vegetation. However, any soil that is rich and mellow, regardless of color, will yield an abundance of good potatoes, providing all other conditions are favorable, including climatic conditions. There are, and always will be, some regions peculiarly adapted to the culture of the potato. We would say, then, that good soil for potatoes must contain a large proportion of humus, and it is well that this humus be well decomposed at planting time, making the soil fine, loose, and without preventing a free circulation of air.

Most potato growers prefer a light, sandy, loam soil. The crop and the quality of the potato is generally poor if planted in an extremely light or a heavy clay soil. The potatoes grown on a mellow soil will be smooth, while those grown on the heavy clay soils will be ill-shaped. But if your soil has already been chosen for your potato crop, and is a heavy, retentive soil, it is better to select some variety of potatoes that are almost round, and you will note the shape of the tubers produced will be much better than those of the longer variety. Another remedy for the poorer and heavier soils is, as I have stated, the use of dry and green manures each year, if possible. By doing this, there will be more plant food and humus put into the soil each year than is taken out, increasing the value and improving the

texture of the soil, as well as the yield and quality of the potatoes.

It is not advisable to plant potatoes in soil ever containing any amount of alkali. It is not a soil suited to the growth of potatoes. Potatoes grown in this soil are generally scabby. If the soil is irrigated during the growing period, the alkali appears on the surface of the ground, comes in contact with the tubers, bites them and causes scab. Land that is deficient in fertility or humus should not be used for the growing of potatoes.

Before the planting of a crop of potatoes, the land should be prepared well. Much of the future success of the crop is dependent upon this condition. The potatoes germinate more rapidly, through the circulation of air, are not likely to decay, and the greater ease of culture of the crop is apparent.

If the soil is dry, irrigate well before starting to prepare it for planting. By digging well into the subsoil, the moisture conditions can be determined; and if there is a shortage, give the land a thorough soaking. The upper moisture should penetrate to the deep subsoil moisture. When the surface is dry enough to work without sticking, plow the ground thoroughly and harrow as fast as a small area is plowed, to prevent the loss of moisture. The soil should be harrowed and re-harrowed until it is fine, moist and mellow. This working kills all the small weeds, and at the same time puts the soil into excellent condition for planting.

If it has not been convenient to prepare the soil so well before planting, it is advisable to plow under the green crop and plant at the same time. If planting in dry soil (where it has been impossible to irrigate) in the late fall or winter, from November to the middle of December, the grower gen-

erally depends upon the first rain to start his crop growing, and he waits till then to work his soil. The potatoes are dropped in the ground while dry, and when the rain comes the surface of the soil is worked before the potatoes are up. This soil must be of a mellow texture. The time for planting this crop is from November to the middle of December.

When planting in wet soil—that is, soil that is never dry, such as the peat land—always plow and work it thoroughly a month or so before planting. If the soil is very wet at planting time, open up furrows with a large cultivator plow, wing shovel plow—in fact, any that will serve the purpose of throwing the dirt both ways, leaving the furrow from five to seven inches deep. If the soil is wet and cold, these furrows should be left two or three days to dry before planting. When the potatoes are planted, cover lightly, not over two inches deep at first. After two weeks, harrow crosswise. This finishes covering them and levels the soil. When covering lightly the first time, use a harrow running lengthwise, keeping the horses on the ridge so they will not trample on the potatoes. In planting in March and April, be careful that the potatoes are deep enough to be out of the way of the tuber moth.

In deeper planting, of about four to six inches, do not cover up the pieces completely, if planted in cold weather; but if planted in the warm season, cover completely. The deeper planting is used in the lighter soils, and shallower planting of about three to four inches in the heavy and retentive soils. In early winter in Southern California, during the months of November, December, January, and as late as the middle of February, the seed is planted shallower, as the ground is too cold and moist. They are planted about three or four inches deep at this time. Deep planting is generally considered the best, except in winter. If the tu-

ber moth is troublesome, it is necessary to plant deeply. The tuber moth makes its appearance more often in soil that has not been worked finely than in the mellow soil. In deep planting, if possible, plant from four to six inches, partly cover, and leave two weeks, then finish covering with a harrow running lengthwise, and with the teeth straight.

If planting while plowing during winter months of November to February, it is best to leave the soil as it has fallen after plowing, for two weeks. Then harrow crosswise at a depth of about two or three inches, working the soil surface thoroughly. After four or five days it should be harrowed again, this time lengthwise of the rows. The last time it should be harrowed crosswise, this being just before the plants are up.

If the soil is fouled with weeds, or a shower of rain comes before the plants are up, the soil is liable to crust; and as soon as the rows can be seen it is well to harrow lengthwise, being careful to keep the horses in the middle of the rows. The harrowing will not injure the tops, and is the first and best cultivation the plants ever get. The harrowing stirs the surface of the soil and leaves it free from weeds, and the soil in excellent condition. The harrow is best for this cultivation, as any other implement, such as the cultivator, leaves a strip of uncultivated soil between the hills.

In planting from the months of March to August, in any soil, the potatoes should be planted from four to six inches deep. However, if the soil is wet, partly cover at first, and in about two weeks harrow crosswise. If the soil is dry and is to be irrigated, they should be covered completely and harrowed thoroughly to hold the moisture.

The medium and main crop is planted in March and April, and in some parts of California as late as the tenth of

May. Potatoes planted in July and August are considered a late planting.

The best season for planting potatoes in ordinary soils, where it is not extraordinarily dry or wet, is from the first to the fifteenth of February, for a heavy yield. For the best price, the time to plant is in December or January. The yields at this time are not so great, and some seasons the crops are apt to be frost-bitten. However, if the grower wishes to take the risk in the early planting, he will receive in pay good prices and a quick sale.

The best season for planting low, wet land, which is more or less subject to frost, is from the twentieth of March to the fifth of April. In higher altitude frost appears later and earlier than in the low altitude. The grower should know when to expect frost. In some places potatoes cannot be planted until the first of May. At this planting, if the seed is taken from a lower altitude, the grower should select his seed from potatoes planted in July or August of the previous year, and dug in December. This seed should be moved to the higher altitude as soon as dug, where they are to be planted by the first of May or later. The seed will keep in a cold climate, but if the same seed were kept in a lower climate the same length of time, it would be too old to plant. The reason for this is that the cold retards the growth of the potato and they stay dormant until the warmer weather arrives.

Another point not known to potato growers is that the changing of soils from year to year keeps it to its highest standard of quality and productiveness. Potatoes grown on a low, wet soil, such as the peat land, should be planted on a higher, drier soil the succeeding year.

In the growing of potatoes it is customary to plant so as to admit of cultivation in one direction only, the rows be-

ing spaced from thirty to thirty-six inches, depending upon the kind of soil, if dry or moist, whether the varieties grown are early or late, if they have naturally large tops and are heavy yielders or small.

In dry soil the rows should be about thirty-six inches apart, so that ditches or furrows for irrigation, in the center of the rows, may be deep enough to run water without flooding the tops. If the tuber moth is troublesome, the rows should be farther apart to admit of better cultivation. The varieties with large tops need wider spacing than the smaller-topped varieties.

Tubers of early or small yielding varieties may be planted closer than those of the large yielding varieties, also when planting in rich soil. There is not much gained by planting too close together, at any time. The yield and size of the tubers are greatly decreased. The early varieties of potatoes do not yield as much as the late potatoes, as they mature much more rapidly.

The seed potatoes are dropped from fourteen to seventeen inches in the hills, always planting one seed piece to the hill. Some growers advocate the use of two pieces to the hill, but if the seed is good, one piece is much better. The hills are generally spaced farther apart when the rows are closer.

A grower who will give it a little thought, will soon learn the variety of potatoes to use in his soil, and the best spacing for them, the fertility of the soil and the size of the tubers desired to be taken into consideration.

Seed potatoes must not be planted too soon after they are dug. It is essential that they have a certain amount of time to lay dormant and rest. The time required is generally from two to three months. In the interior or where the climate is warm, less time is required than along the coast.

However, the seed should be six weeks old before it is planted. Seed for the July and August planting should have been planted in December and January to be of the proper age. For good seed to plant in December and January, the potatoes should have been planted in the latter part of March or the first of April. To plant in March and the first of April, the seed potatoes should have been planted the year preceding. Potatoes may be forced to grow sooner, but by forcing the growth the yield will be less than when they have a longer rest period. They must have time to change from starch to sugar. It is this chemical change that takes place before the potato begins to grow. The bud-eye portion of the potato develops a sprout sooner than the stem end, as this change takes place more readily. The bud-eye cluster or the blossom end of a potato develops quickly and has more vitality, but the tubers produced from that end are generally rough and are varied in size. The stem end will produce more uniform potatoes. However, if a tuber is diseased, this is the first to be affected. If an early crop of potatoes is desired, the bud-end pieces may be used, as they grow more rapidly. I have experimented by planting pieces cut from the stem and blossom ends separately. I find that those planted from the stem end become more uniform in size and shape from successive plantings.The longer this practice is continued the more uniform these potatoes become. The longer the bud-eye is planted the rougher the tubers produced become. It is the center eye of this end that finally causes the "running out" of the potato, and in growing is the first eye to show, and is the first eye to grow when planted.

In the planting of seed potatoes, I would advise the grower to avoid all planters that will bruise or cut them, as

such seed when planted is liable to decay. Since it loses its vitality, disease germs are free to enter.

In conclusion of this chapter, I would emphasize the following:

1st. Good seed.

2nd. Cultivate deeply as well as thoroughly.

3rd. By the use of fertilizers humus is added to the soil.

4th. The soil should be prepared well before planting.

5th. It is a wise policy to change soils from year to year.

6th. Do not plant too close together. This is a common error.

This illustration shows how to plant to reproduce on top of the vine. This also isn't practical, unless the grower wishes a number of tubers to plant the following year. The line shows the depth the top should be planted.

CULTIVATION AND IRRIGATION.

CHAPTER V.

RACTICALLY all the cultivation of a potato crop is done before they are up, although the growing plants need a great amount of thorough cultivation. Cultivation is not only for the purpose of loosening the soil, therefore conserving the moisture, but for the killing of weeds and germs as well, and allowing the sun, heat, and air to penetrate the soil, thus causing the decomposition of the fertilizers and allowing the tubers the ideal conditions they require during formation. The thorough cultivations warm the soil and cause a deeper root system. Therefore cultivation increases producing power, by retaining the moisture, making the plant food available, allowing a circulation of air to pass about the forming tubers, and killing the weeds, thus allowing the plant food that would be uselessly wasted to go toward making a better crop.

Level cultivation generally proves more satisfactory—that is, where the climate and soil conditions are favorable. However, where irrigation must be practiced, the hill culture or ridge system is used. Level cultivation is practiced where the soil is of a naturally moist nature, or in soils where

the grower depends upon the rains to produce his crop. When hills are thrown up there is a greater amount of surface soil exposed to the sun, and, consequently, the evaporation of the moisture is greater.

The first cultivation after the plants are up and the rows can first be distinguished is with the harrow, running lengthwise of the rows, being careful that the horses are kept in the middle, so they will not trample on the plants. This harrowing will not injure the tops and is the best cultivation the plants ever get.

After the first cultivation with the harrow, when the plants are up two or three inches, the cultivator is used. On a small farm, where one-horse cultivation is practiced, such an implement as the five-tooth cultivator best serves the purpose. It will keep the surface of the soil fine and mellow. It is wise to use the small sized teeth at first, so too much dirt will not be thrown against the tops. However, cultivate quite deeply. Always cultivate as closely to the rows as possible without injuring or covering them with dirt. After the first cultivation it is well each time to cultivate farther from the plants than the preceding cultivation, as the tubers are forming, and when the feed roots are broken a certain per cent of vitality is taken from the growing plant.

After irrigation, or after a rain, when the soil becomes dry enough not to stick, it should be thoroughly cultivated, and particularly well if the soil is inclined to bake or crust. If the soil is fouled well with weeds or weed seed, the more frequent and thorough the cultivations the less hand work is needed. It is impossible to state definitely the number of cultivations needed in the growth of a crop of potatoes. The climatic conditions, the character of the soil, and the amount of weeds determine the frequency of cultivations needed. It

is well to use the cultivator as much as possible, as the hoe cuts and bruises more small tubers than the cultivator, if handled properly. When the soil has a great amount of weeds, the field may be harrowed just before and after the plants are up, and cultivated well; then the weeds may be kept in check without a great amount of hand labor.

Some potato growers believe that a small amount of cultivation after the plants are up is all that is necessary, but I have learned that the more frequent the cultivations, without destroying the vines, the better. When the tops have grown too large to cultivate without tearing them it is best to discontinue this kind of cultivation. However, if the weeds still persist, then the hoe may be used. The weeds should have been destroyed before this time, as they use up the moisture and plant food rapidly.

Potatoes, when irrigated, do not have the good quality as when grown in a naturally moist soil, although the larger acreage devoted to potato culture in California is irrigated. When it is necessary to irrigate, those irrigated by capillary attraction are of much better quality than those that are soaked or flooded.

In the warm climates, where irrigation is necessary before the plants are up, a deep furrow should be made in the center of the rows to run the water in so that the moisture may be drawn up by capillary attraction, making the hills in a comparatively loose open ridge. The furrows in the center of the rows insure even cultivation. In such warm climates the soil should be irrigated very lightly just after planting, as the moisture in the soil may have evaporated to a certain extent during cultivation. After this light irrigation, when the soil is dry enough not to stick, cultivate well and near the hills. This kills the weeds that may have started by irrigating. Each cultivation after the first should be

farther away from the rows and towards the center—a harrow-tooth cultivator or one that will serve the purpose of mellowing the soil. If it is necessary to irrigate more than once, deepen the center furrow again and cultivate after the irrigation. When using the harrow-tooth cultivator it is well to narrow it so it will not tear down the loose soil that has been thrown up against the potatoes. It should be just wide enough to stir the wet soil in the center of the rows.

Never allow the soil to become too dry. It should be in a mellow, fine and moist state always, but not wet. When the soil becomes too dry, after the tubers are a certain size, and is then irrigated, a new growth starts, and the result is knotty tubers, and they are of a poor quality. Never allow the water to soak around the potatoes, but allow the moisture to be drawn up by capillary attraction. The best way to determine the need of irrigation is to dig in the subsoil beside the large vine, one that is forming tubers, as they use up the moisture more readily than the smaller vines. If the soil around the hills becomes too wet the leaves turn pale, and when too dry, they become a bright, dark green shade.

When the tubers have begun to ripen they should be allowed to mature in comparatively dry soil, so the skin may toughen before digging.

In planting where hill culture is practiced, it is a wise plan to grade the land. If graded to a gradual slope, when irrigated or when rain comes the water will not stand in any one place. If it stands in one place long it causes the soil to become water soaked and soggy. When such poor conditions exist the result will be very unsatisfactory, generally making the tubers scabby and of a poor quality. On the other hand, if the slope is too great, the water will make deep ditches or washes, causing the grower severe losses.

Potato insect pests. (a) is the small green hopper, called Empoasca Mali. (b) is the Black Flea Beetle. (c) is the Tuber Moth, and Worm.

On moist soil, such as peat land, where level cultivation is practiced, the best method of planting is to make deep furrows, then, after planting, the soil is harrowed lengthwise, covering the pieces lightly. After two weeks it is harrowed again, this time covering them more, but not completely filling the furrows. Afterward, in the first cultivation, the loose soil is rolled up to the rows, making the soil level, then a small harrow-tooth cultivator is used, one that will keep the surface level. This is called level cultivation, and is practiced on soils containing natural moisture.

In conclusion of this chapter on "Cultivation and Irrigation," I would emphasize these points:

1st. Always cultivate thoroughly.

2nd. Allow the potatoes to mature in practically dry soil.

3rd. Never allow the soil to become too wet. Potatoes grown in such soil are of a poor quality, more liable to disease, and the yield is less.

4th. The number of irrigations depends upon the climatic and soil conditions. One may be sufficient, but in some instances five or six, or even more, may be needed.

5th. Cultivate the soil well before planting and less will be needed after planting.

6th. Never allow the potatoes to become too dry. If irrigated after they become too dry a new growth starts and prongy tubers are the natural results.

DISEASE AND ITS PREVENTION.

CHAPTER VI.

THE various diseases, such as scab, blight, jelly-end rot, wilt and rhizoctonia, which are more prevalent in the northern districts of California than the southern part, could be almost eliminated if the careful system of seed selection, such as I have recommended, was followed. Very fortunately for the potato growers, more attention is being given to the selection of vigorous seed.

When good and pure seed has been selected, the grower should now turn his attention to these disease germs. The best method is to plant a legumus crop of Melolotus Indica, or Red Oats, or most any good green crop that will grow rapidly and vigorously. When this is turned under the acid formed will play havoc with the disease germs.

After careful cultivation and planting, when the potatoes have grown to about two or four inches high, it is wise to spray with the Bordeaux mixture. I recommend spraying at this time rather than later, as this spray is a preventative of disease, rather than a cure, and the sooner the plants are sprayed the better. If the disease is in the

seed piece or soil, it will make its appearance sooner or later, and, if the disease is to be prevented, it should be taken in time.

Some growers advise first spraying the plants when a certain age. Would it be wise if smallpox, or any dreaded disease, prevailed in a family, and some had been exposed to it, to wait until the child was a certain age to vaccinate? No, this should be done early, in order to prevent it. This same precaution should be considered in the growing of a crop of potatoes.

After the first spraying, the plants should be sprayed about every two weeks during their growing season. However, the crop should be sprayed just after a shower of rain, as it is such conditions as rain followed by sunshine that causes blight. These spores increase so rapidly that the whole field might be blighted down in two or three days if the sun shines warmly. Therefore, I would say that the whole idea of spraying is to protect the vine when the disease appears.

If Paris green is added to the Bordeaux, the mixture will adhere to the leaves, and, as it is a poison, no insects can eat of it unless they are poisoned. Since it is a poison, it should be handled carefully and kept away from children or stock.

Not only is the use of this mixture advisable for insects and disease, but for the increased vigor of the plant from its use. All sprayed plants are larger and darker green, live longer, are hardier, and produce a better crop. I should advise to always use at the rate of one-half pound of Paris green to each fifty gallons of Bordeaux mixture.

It is well to use a high pressure spray with fine nozzle, so that all sides of the leaves are thoroughly coated. If the

This illustration shows a potato affected with the Wilt.

vines are not sprayed thoroughly the insects may gain foothold and a portion of the crop be destroyed.

In preparing the Bordeaux mixture, if a small amount is to be made, have ready two half-barrel tubs, one for the copper-sulphate solution, and the other for the lime solution. In one tub place five pounds of lime and slake with sufficient water to thoroughly break up the lime without allowing it to burn. After it has been thoroughly slaked, add enough water to make five gallons of this solution. In the other tub, put five gallons of water and suspend five pounds of copper-sulphate in a gunny sack, so that two-thirds of the copper-sulphate is in water and the other part in air, as it requires air and water to dissolve. This should be dissolved in about twelve hours. These are called the stock solutions and will keep for some time if kept in a cool place, but when they are mixed the spray should be used immediately. When ready to spray, mix and pour enough water into it to make fifty gallons in all. When strained and mixed thoroughly it is ready for use. The solutions should always be kept thoroughly stirred.

The spray treatment is generally used for the blight, yet when the Paris green is added it is equally effective for the small insects, such as the black flea beetle and the Empoasca Mali, a little green hopper. If blight and insect pests are eliminated there will be less of the other diseases because of the consequent healthy condition of the plants.

When potatoes are blighted the larger portion of the tubers are subject to a rot called "Jelly-End," and sometimes, when dug early, before it appears, they are generally subject to "Dry Rot." As the blight is in the seed piece and soil, it is wise to select good seed and spray to prevent the appearance of the blight. Few people know or can appreciate the injury done by the little black flea beetle. They at-

tack and live on the leaves of the plant, and the damage they do to the living plant is immense. They eat small holes into the leaves, and, as the leaves are the "lungs" of the plant, it is easily understood why these pests are so injurious to a crop. These beetles are generally found on the under side of the leaf.

The Empoasca Mali, a small, green hopper, feeds on the under side of the leaf and seems to suck the very life from the plant. As they increase very rapidly, a large amount of vitality is taken from the vine before they are noticed, and, indeed, many crops are destroyed by them.

Scab is a very common disease of the potato, but is not so serious as generally supposed. There are several causes for the scab: 1st. Alkali in the soil. 2nd. Too much dry manure. 3rd. Poorly drained soil, as the alkali of the soil when too damp will appear on the surface. The best remedy for this disease is the use of the green fertilizer, the acid from which counteracts the effect of the dry manure. When this is persistently carried out, I find that there is no need of "dipping" for scab. However, if it seems best, the grower may soak the seed in a solution of corrosive-sublimate for one and one-half hours, made at the rate of one ounce of powdered corrosive-sublimate to eight gallons of water. As this is a poison, it should be handled with care. It is a stronger poison than the formaldehyde solution, therefore, serves the purpose better. Since this disease stays in the soil, it is best to treat it by the use of green fertilizer. Even if very little disease exists, it is always wise to combine the dry and green fertilizer, and the grower will unusually be successful.

Wilt is a disease which works in the vine and cannot be reached by spraying. As this disease goes from the stem into the tuber, it is well to harvest before maturity. This

disease causes the vine to wilt, and often leaves the tubers about half the size they should be, and these diseased tubers decay quickly.

When the plants are infected with wilt or blight, there is always a shortage of starch, causing them to decay quickly. If this does not happen, the food value will be greatly decreased. When the tuber is first formed it consists chiefly of water, and as it grows the starch is formed. Changing the seed from one soil to another from year to year not only increases the yield, by making the seed more free of disease, but by increasing the starch content. As the feed roots give nourishment to the vine, when the vine is affected by these diseases, the food supply is cut off from the tuber, and, instead of plant food, the disease in the stem is taken into the tuber.

The hills of potatoes with wilt always have small tubers, and, if these small tubers of a field are not eliminated, they will be used as seed, and, consequently, the wilt will appear the following season. The wilt is always introduced into a clean field by a diseased tuber. The only way known to control this disease is to eliminate the diseased tubers from the stock.

The tuber moth is a small moth or fly and generally appears in the tubers that are dug and left in a pile. They are seldom seen in the peat land, but do appear at times. They can gain a better foothold on the drier, cloddy soils. In early plantings, I always dig and market before the potatoes are mature, before the tuber moth appears. They seldom bother a fall crop, planted in July or August, unless the soil is cloddy, which, of course, is an unfavorable condition for the soil to be in for potatoes. The potatoes that are dug before fully matured are less liable to disease, as they have less time to grow, and the disease does not have the time to go into the

tubers. When the tubers are cut, the disease germs may enter easily.

Gophers are another pest to the potato grower. They will do a great amount of damage in one night, by cutting the vines. If the vines grow again the tubers that appear will be prongy, and sometimes will cause small tubers to grow on the vine, between the leaf and the stalk.

In conclusion of this chapter on "Disease and Its Prevention," I would emphasize the following points:

1st. Above all things, **never plant diseased potatoes.**

2nd. The more thorough the cultivation and the richer the soil, the less liable are the tubers to disease.

3rd. Cull potatoes are responsible to a great extent for the increase of disease and should always be removed from the fields at harvest time.

4th. In spraying it is well to use a high-pressure spray and a fine nozzle.

5th. Never leave volunteer potatoes in the field from year to year, as it is these small diseased tubers that cause the spreading of disease.

The Scottish Chief potato is the best marketable tuber known.

HARVESTING AND MARKETING.

CHAPTER VII.

THE first step in the grading of potatoes takes us back to the selection of seed. Unless good seed is selected to produce the crop, we cannot expect a yield of good marketable potatoes. The few potatoes produced from poor seed vary so greatly in size and shape and are of such poor quality that twice the amount of work is required to grade. However, it is just such poor stock that is generally found in the stores and markets, and, consequently, must be sold for a low price. If a strict system of seed selection and grading of the stock was used, a better price could be demanded, and the consumer would gladly pay the extra cost for the better quality.

The general lot of potatoes found on the market are poor in quality, small, diseased, and, therefore, lacking in food value. The loss to the consumer, as well as the buyer and producer, is great, being about 50 per cent, whereas, potatoes grown from good, well-sorted seed are not only more palatable, but there is a very small per cent of waste.

When a potato is cut lengthwise, in the center will be seen a layer resembling the trunk of a tree, with branches

running to each eye. This is called the internal medullary layer and consists chiefly of water. In the analysis of a potato with few eyes, it is found that it has much better food value, as it is largely indicated by starch content, and the part containing the most starch is near the surface. This is called the cortical layer. Thus, we would conclude that the potato with few eyes would not only be less waste, and be more palatable, but would contain more food material.

In propagating and breeding my new potatoes I have always been most careful to select those that are smooth and with fewest eyes, and, consequently, have the best in food value.

Unfortunately, the average grower has paid little attention to the production of the good quality potato, but has grown them with as little expense as possible, regardless of the palatability, not once thinking of the expense of shipment of these culls, and, on account of the absence of starch, the short time in which they remain free from decay. The consumption of such potatoes is small, because of the unpalatability. However, they are called potatoes, and are used as an article of diet.

If sixty per cent of the average run of potatoes were sent to market and about forty per cent kept to feed stock, the grower would gain more by those sent to market, because of the higher price, besides having the forty per cent to feed stock.

In my experience in handling graded stock, I have always received from fifty to seventy-five cents more per hundred than most potato growers, and have always found an ever-ready market for such graded stock.

I generally grade in two grades, but, if I only have one grade for market, that is always the best. When the dealer may depend on the grade there is always a ready market.

Young's Early Harvest King. This is the greatest yielder of any early variety known, and is of excellent quality.

It is well when grading to grade as though you were buying the stock yourself. Every grower has his particular way of digging, but whether it be with plow, digger or hook, do not cut or bruise the tubers or throw them into piles, as they will rot easily if handled roughly. If grading for market while digging, the potatoes should be allowed to dry before being sacked, so the soil will not adhere to them, making them rough looking. However, they should never stay in the sun too long. Such treatment causes the tender tubers to green and decay quickly.

If potatoes are not marketed immediately they should be kept in a cool, dry, shady place and covered so that the light, air or sun may not strike them. If it does they will turn green, and, in so doing, a chemical change takes place in the cortical layer, making the potato unpalatable, the flavor being rather sweetish, and sometimes bitter.

In harvesting the early crop in particular, it is best to harvest before maturity—that is, before the vines are dry, so the disease cannot enter the tuber through the stem. In so doing the tubers will keep longer for seed or for marketable purposes.

As to the quality of the potato, I may say that all conditions of environment that lead to the normal development of a healthy, mature potato contribute toward its quality. The potato planted in soil three inches deep is of poorer quality than those planted from five to seven inches deep. I find that when they are planted from five to seven inches deep the temperature is of more uniformity during the growing season than at shallower depths. Not only does the depth at which the potato is planted determine its quality, but the fertilizer, season and variety as well.

Fertilizers have a decided influence over the quality of the potato, as they aid in producing a normal development

of tubers by furnishing an element of fertility which is lacking in the soil. Some conditions that affect the table quality of the potato are, size, and shape, fertility of soil, cultivation, climate and season, maturity, and in general the quality is increased with the thickness of the cortical layer, and decreases as the number of eyes increase.

In conclusion of this chapter, I would impress some points upon the reader's mind:

1st. Use good grading system, thereby building up a good market for your particular grade.

2nd. Never leave culls in the field to become a volunteer crop the following season. This will finally cause the "running out" of the potato, and where disease is evident and the crop is harvested in this careless manner, the following year will increase the amount of disease.

3rd. Handle the tubers as little as possible, and carefully.

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